E950 Results

J. Tojo

RHIC Spin Collaboration Meeting
October 1, 2001
RIKEN BNL Research Center, Brookhaven National Laboratory

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Junji Tojo
Kyoto University / RIKEN

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BNL-AGS E950 Collaboration

I.G. Alekseev[4], M. Bai[2], B. Bassalleck[8], G. Bunce[2,7], A. Deshpande[7], J. Doskow[3], S. Eilerts[8], D.E. Fields[8], Y. Goto[7], H. Huang[2], V. Hughes[9], K. Imai[5], M. Ishihara[7], V.P. Kanavets[4], K. Kurita[7], K. Kwiatkowski[3], B. Lewis[8], B. Lozowski[3], Y. Makdisi[2], H.O. Meyer[3], B.V. Morozov[4], M. Nakamura[5], B.V. Przewoski[3], T. Rinckel[3], T.Roser[2], A. Rusek[2], N. Saito[6,7], B. Smith[8], D.N. Svirida[4], M. Syphers[2], A. Taketani[6], T.L. Thomas[8], J. Tojo[5,6], K. Yamamoto[5], L. Zhu[5], D. Wolfe[8], D. Underwood[1]

[1]Argonne National Laboratory
[2]Brookhaven National Laboratory
[3]Indiana University Cyclotron Facility
[4]Institute for Theoretical and Experimental Physics, Russia
[5]Kyoto University, Japan
[6]RIKEN, Japan
[7]RIKEN BNL Research Center
[8]University of New Mexico
[9]Yale University

Two Aspects of E950 results

- **Analyzing power A_N for RHIC CNI Polarimeter**

  The only calibration point at 21.7 GeV/c ($G\gamma$=41.5)
  up to the operation of the polarized gas jet target
  (RHIC injection energy: 24.3 GeV/c ($G\gamma$=46.5))

- **Physics interest**

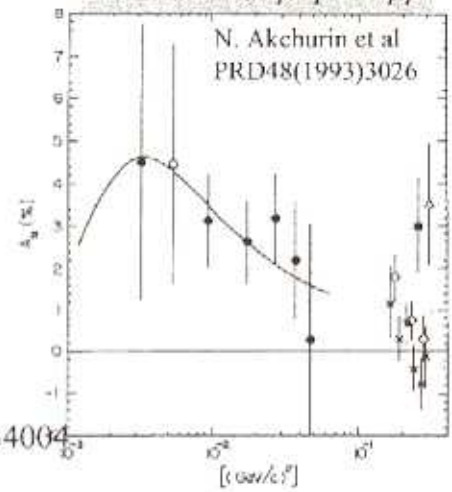
  Hadronic spin-flip r_5 at high energy

$$r_5 \equiv \frac{m_N}{q}\frac{F_s(q)}{\mathrm{Im}\,F_o(q)}$$

$F_s(q)$:spin-flip amp., $F_o(q)$:spin-nonflip amp.

Recent theoretical developments
on pA elastic scattering including r_5
B.Z. Kopeliovich and T.L. Trueman, PRD64(2001)034004

FNAL-E704 $p^{\uparrow}p \rightarrow pp$



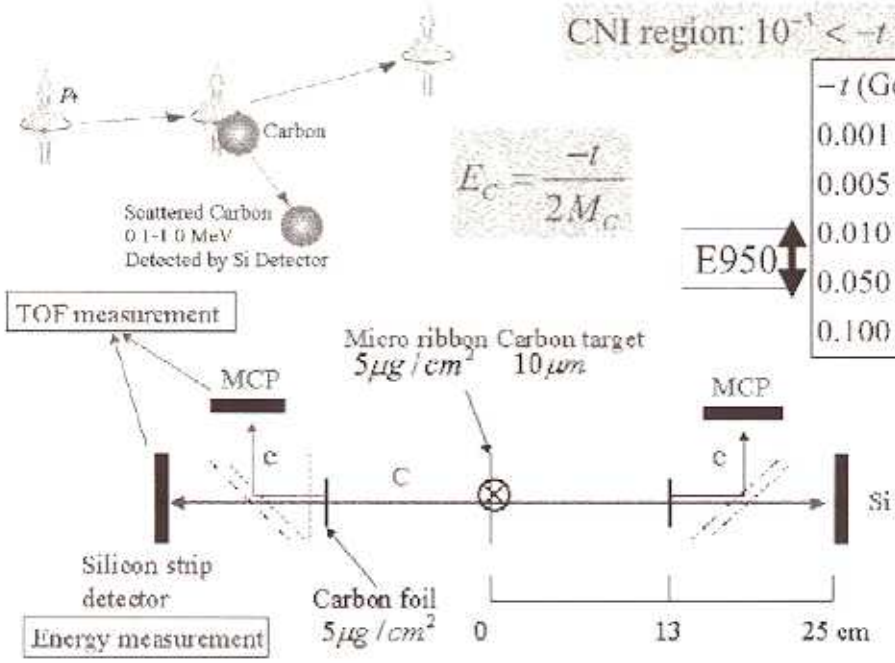
Kinematics / Detector configuration

CNI region: $10^{-3} < -t < 10^{-2}$ $(GeV/c)^2$

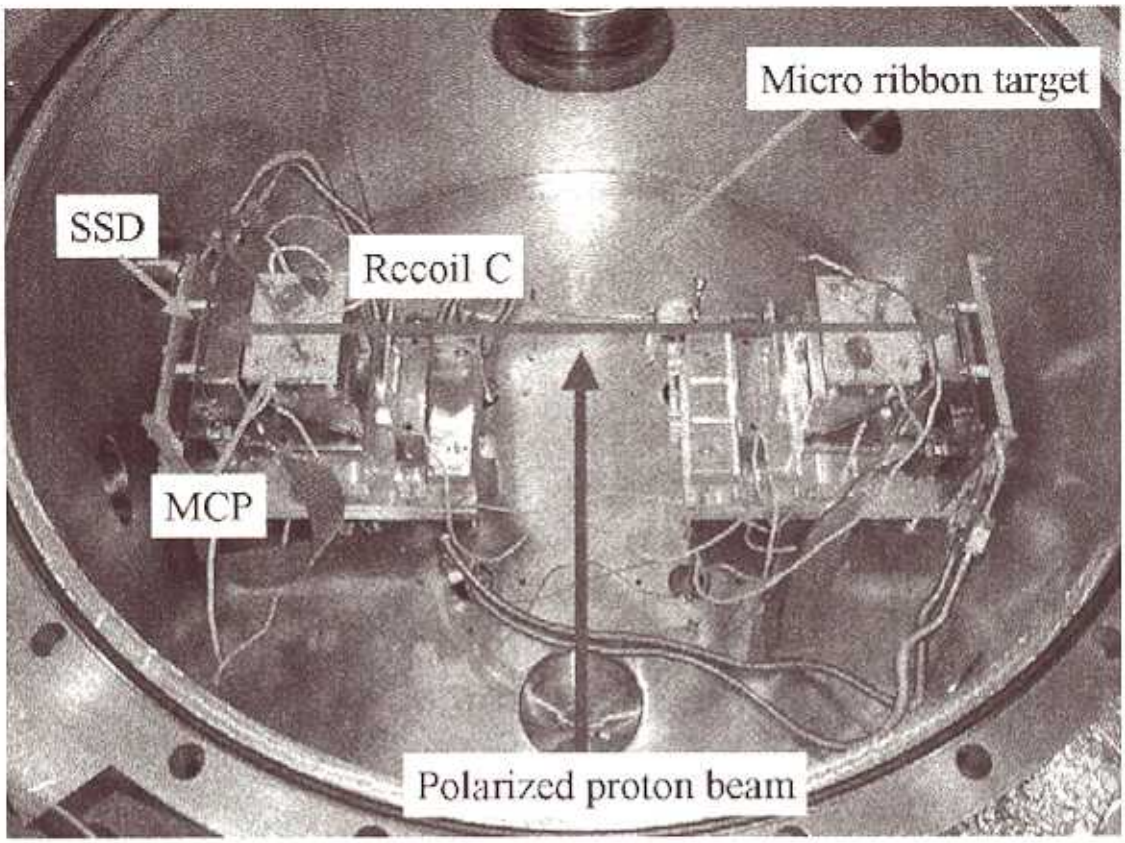
$-t$ (GeV/c)^2	E_C (keV)
0.001	45
0.005	224
0.010	450
0.050	2236
0.100	4473

E950

$$E_C = \frac{-t}{2M_C}$$



6ch,4mm/strip
surface: bare Si



Experimental Run Condition

- **Bunched polarized proton beam in the AGS ring**

  Momentum : 21.7 GeV/c

  Polarization : ~40% (from the AGS-internal/E925 polarimeter)

  Polarization sign : Up and Down alternated every spill (↑↓↑↓↑↓)

  1 bunch/ring, 5×10^9 protons/bunch

  Bunch length : 25 ns ($\sigma \approx 6ns$), Bunch crossing freq. : 370 kHz

- **Trigger**

  $(\sum_{All} \oplus Si) \otimes RF$, Trigger rate : 2×10^3 / *spill*

- **Data**

  ADC/TDC for all Si's and MCP's

  Beam Polarization, its sign and beam intensity from the AGS

Detector Performance

- **Si strip detector**

Recoil carbon detection w/ Si

Clearly seen in T-vs-E corr.

Successfully detected inside the ring.

Energy resolution

from low energy exp. and E950 data

$$\frac{\Delta E}{E} = \frac{0.05}{\sqrt{E}} \oplus (0.05 - 0.12)$$

Time resolution

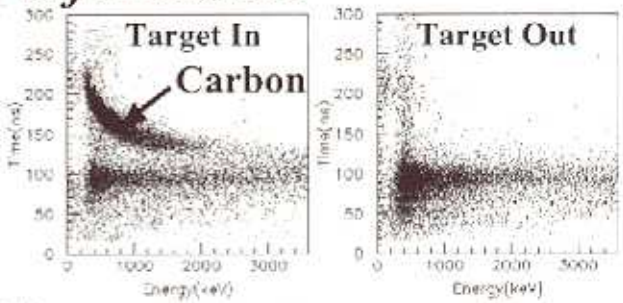
dominated by bunch length

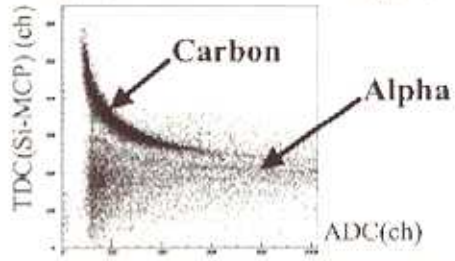
$$\Delta T \; ; \; 7ns$$

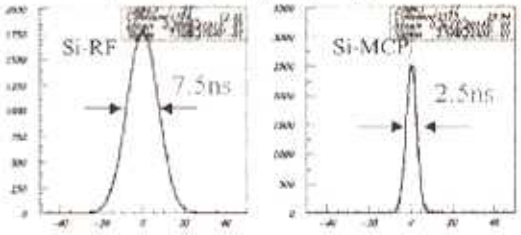
- **Micro Channel Plate(MCP)**

Improved Time resolution $: \; 2.5ns$

Intrinsic Time resolution of Si







Analysis Procedure

- **Calibration of detectors**
- **Event selection**
- **Study of detector resolution**
- **Definition of Momentum transfer**
- **Backgrounds estimation**
- **Beam polarization from E925 Polarimeter**
- **Analyzing power**
- **Systematic errors**

Event Selection

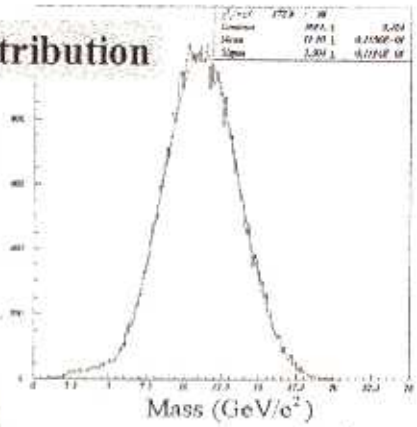
- **Selection on –t-vs-Mass**

(-t was defined from Time and Energy)

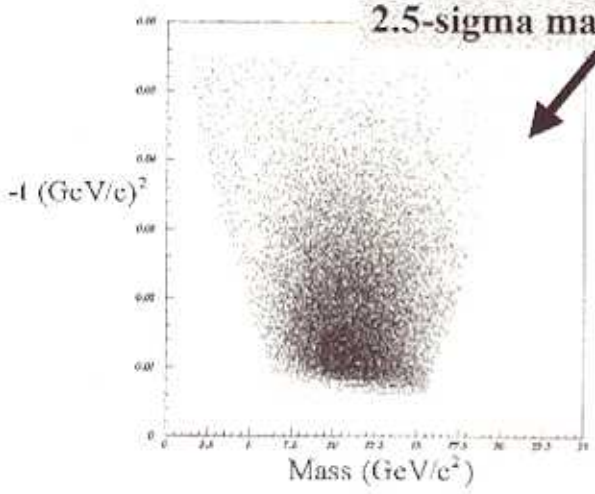
- **Cut using Mass**

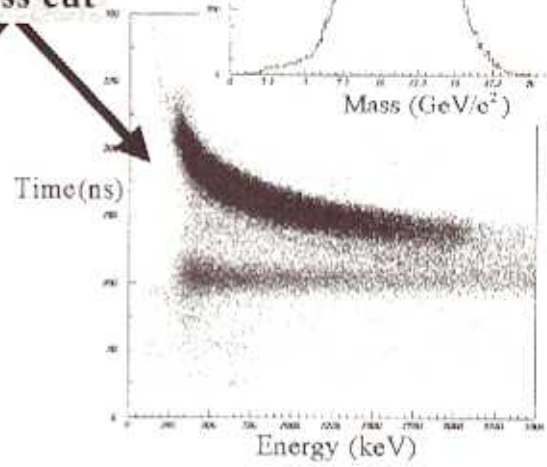
Based on –t-dependent mass resolution

Mass distribution



2.5-sigma mass cut





Study on Detector Resolution

- **Strip-by-strip resolutions for Energy, Time and Mass**

Important to define cut and momentum transfer

Mass resolution from Kinematics

$$\left(\frac{\Delta M}{M}\right)^2 = \left(\frac{\Delta E}{E}\right)^2 + 4\left(\frac{\Delta T}{T}\right)^2$$

Energy resolution

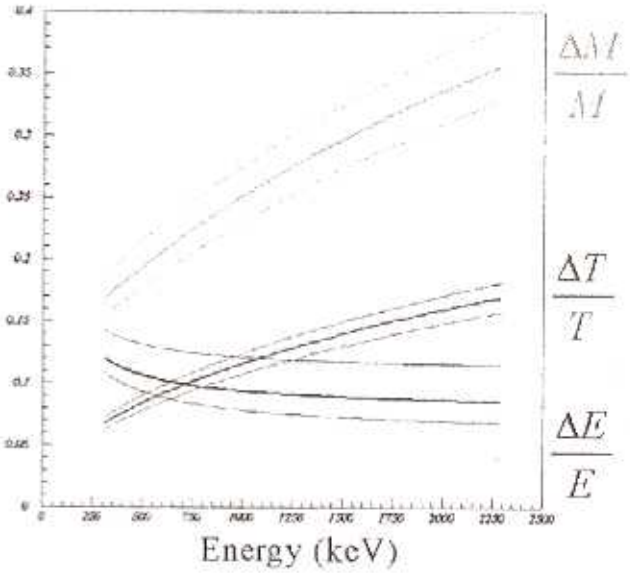
From Low E test exp. and E950 data

$$\frac{\Delta E}{E} = \frac{0.05}{\sqrt{E(MeV)}} \oplus (0.05 - 0.12)$$

Time resolution

Dominated by bunch length

$$\frac{\Delta T}{T} = \frac{(7.0 \pm 0.5)ns}{T}, \quad T = \frac{L}{c}\sqrt{\frac{M_C}{2E}}$$



Momentum Transfer

- **Determine from both Energy and Time: t_E and t_T**

$$t_E = 2M_C E_{Tgt-Foil}(E_{Si})$$
$$E_{Foil-Si} = E_{Si} + \Delta E_{Dead}(E_{Si})$$
$$E_{Tgt-Foil}(E_{Si}) = E_{Foil-Si} + \Delta E_{Foil}(E_{Foil-Si}) = E_{Si} + \Delta E_{Dead}(E_{Si}) + \Delta E_{Foil}(E_{Si})$$

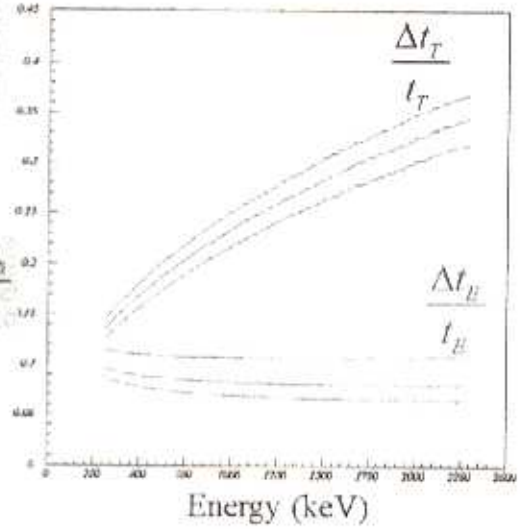
$$t_T = 2M_C E_T(T_{Tgt-Si})$$
$$T_{Tgt-Si} = \frac{L_{Tgt-Foil}}{c}\sqrt{\frac{M_C}{2E_T}} + \frac{L_{Foil-Si}}{c}\sqrt{\frac{M_C}{2E_{Foil-Si}(E_T)}}$$

- **Define w/ weighted mean in terms of resolutions**

$$\frac{\Delta t_E}{t_E} = \frac{\partial E_{Tgt-foil}}{\partial E_{Si}}\frac{E_{Si}}{E_{Tgt-Foil}}\frac{\Delta E_{Si}}{E_{Si}} \qquad \frac{\Delta t_T}{t_T} = \frac{\partial E_T}{\partial T_{Tgt-Si}}\frac{T_{Tgt-Si}}{E_T}\frac{\Delta T_{Tgt-Si}}{T_{Tgt-Si}}$$

$$-t = \frac{w_E t_E + w_T t_T}{w_E + w_T}$$

$$w_E = (\Delta t_E / t_E)^{-2},\ w_T = (\Delta t_T / t_T)^{-2}$$



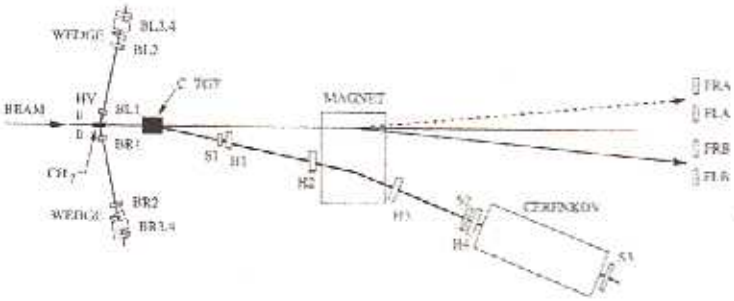
Beam Polarization Measurement

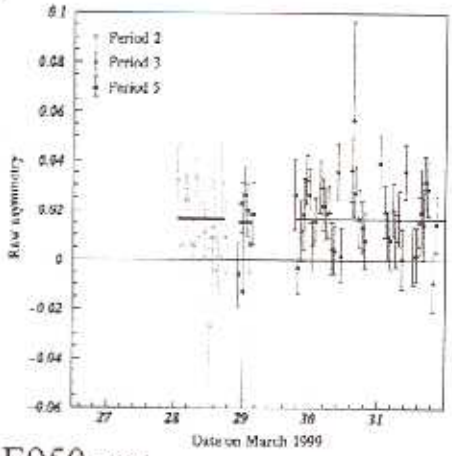
- **E925 polarimeter: pp elastic scattering at** $-t = 0.15\ (GeV/c)^2$

Analyzing Power: $A_N = 0.040 \pm 0.0048$ from global analysis

Target: CH_2, (Carbon for BG study), Two Forward/Recoil detector arms

Setup figure from K. Krueger et al., PLB459(1999)412





Beam was extracted to E925 beam line.

Beam Polarization had been measured during E950 run.

P_B ; 40%

Analyzing Power

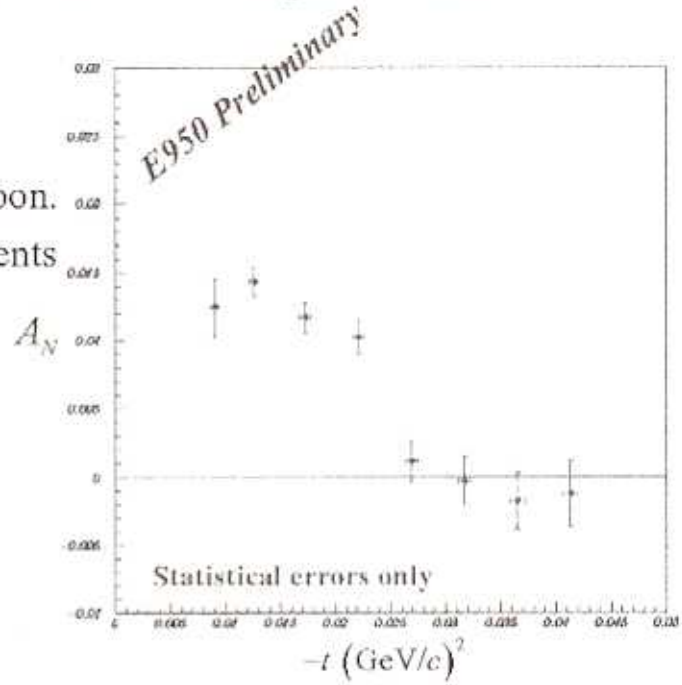
- **Combine raw asymmetry from E950 and polarization from E925 polarimeter**

BGs are contained.

BGs subtraction will be done soon.

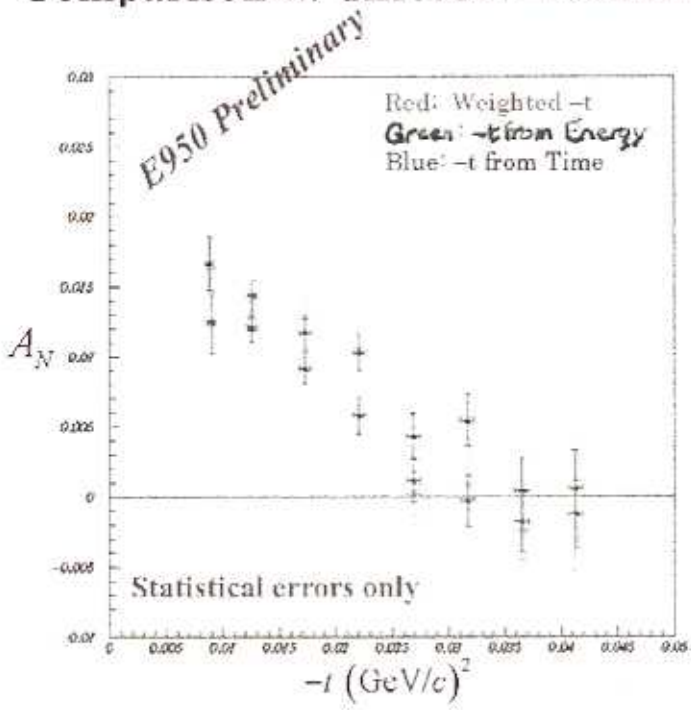
At most ~20% from Prompt events and Alpha fragments.

Systematic error estimation are on going (almost done).



Possible Size of Systematic Error

Comparison w/ different –t binning



Summary

- **Analyzing power $A_N(t)$ of pC elastic scattering in the CNI region was measured for the first time at 21.7 GeV/c.**

- **Preliminary result of $A_N(t)$ are shown.**

- **Background and systematic error estimations are on going. The final result are coming soon!**